THE

Malayan Agricultural Journal.

Vol. XVI. SEPT.—OCT., 1928. Nos. 9 & 10.

PALM DISEASES IN MALAYA.

A. SHARPLES.

PART I. (a) GENERAL.

INTRODUCTION.

Recently, a considerable amount of scientific attention has been given to problems connected with the cultivation of Coconut Palms and several papers dealing with observations on Diseases of Coconut Palms have been issued. (7). (10). (3). The writer has been working for the past few years on Palm Diseases in Malaya, and as evidence has been collected to allow definite opinions to be formed, the present seems to be a suitable time for a general account, so as to compare the results with those obtained in other countries.

Investigations on Palm diseases have been practically limited to affections of the Tall Coconut (*Cocos Nucifera* L.). This palm is the only one which has been exploited on large scale plantations for any considerable number of years; recently, large areas of African Oil Palm (*Elaeis guinensis*. Jacq.) have been planted in Sumatra, Java and Malaya.

Up to 1918 there was little exact knowledge on the subject of Palm diseases; one of the reasons for this lack of exact knowledge may be ascribed to the misunderstanding of the nature of the (usually so-described), dangerous epidemic disease, known as "Bud-Rot". The growth habit of palms is well understood by most people interested in their cultivation. The important tissues, commonly known as the bud tissues, responsible for growth in height and leaf development are enclosed and strongly protected by a close envelope formed

by the bases of the fully developed leaves. This bud tissue is soft and, as rapid development takes place in a healthy tree, much food material is stored in the soft bud tissues. Any circumstance which leads to decreased protection of the bud-tissue leads to a greater possibility of intrusion of numerous organisms, usually saprophytic, which can grow and multiply rapidly in the nutritive bud tissues. The multiplication and growth of such organisms, reduces the white, sweet smelling bud-tissues, to a dark coloured, putrid, evil-smelling mass; not many years ago all trees showing such degeneration were grouped together as "Bud-Rot" trees and after the publication of Johnstone's paper (6), the cause of such "Bud-Rot" was considered to be a specific organism, namely —*Bacillus coli*. (*Escherlich, Migula*). As the present time, it is generally recognised by all investigators of Palm diseases that "Bud-Rot", as commonly understood by planters, can be ascribed to many causes.

Known Diseases of Coconut Palms in other Countries.

The problem dealt with in this paper is mainly one relating to diseases of Coconut Palms and African Oil Palms. Some information regarding established diseases of these crops is, therefore, of interest at this point.

In 1918 the Coconut Palm "Bud-Rot" puzzle was simplified by the researches of Nowell (8) in the West Indies, who showed that a large number of apparent "Bud-Rot" cases were actually caused by the attacks of a Nematode worm, *Aphelencus cocophilus* Cobb. This nematode affection is now well established and is commonly known as "Red Ring disease of Coconuts". As far as the writer is aware there has been no report of this affection in Eastern countries where Coconuts are grown.

In 1919, Ashby (2) in the West Indies, reported two diseases of Coconut Palms caused by fungi of the genus Phytophthora. The first was "Bud-Rot", caused by *Phytophthora palmivora*. Butl., and inoculation experiments showed this fungus to be capable of causing a true "Bud-Rot". The second fungus, *Phytophthora parasitica*, Dastur, was isolated from a leaf-stalk rot of Coconuts. In 1919 Reinking (11) in the Phillippines, isolated *Phytophthora faberi* Maub., from

Coconut Trees suffering from "Bud-Rot", and produced evidence to indicate that this fungus was the cause of the disease, Bacteria being relegated to a secondary role.

Recent work has shown that *P. palmivora* Butl. and *P. faberi* Maub. are strains of the same species, so that the cause of "Bud-Rot" of Coconut Palms in the Eastern and Western Hemispheres proves to be the same.

For many years investigations have been carried on in India on the "Bud-Rot" problem. The Indian problem was primarily one, dealing with the Palmyra Palm (*Borassus flabellifera* L.), and it was proved that the cause of this "Bud-Rot" was a fungus, *Phytophthora palmivora* Butl. The final observations of the investigators in India were published in 1923 (7) and substantially support the work of Ashby and Reinking. The important point in this paper for Malayan Coconut planters is that "But-Rot" of palmyra palms caused by *P. palmivora* Butl. is a serious epidemic disease but can be controlled by systematic measures; *that, comparatively, Coconut palms in a badly infected area of Palmyra palms,* show relative freedom from "Bud-Rot" disease caused by *P. palmivora* Butl.

A recent publication by Briton-Jones (3) deals with a disease of Coconuts in the West Indies, to which the name of "Bronze Leaf Wilt" is given. The external symptoms of "Bronze Leaf Wilt" and Red Ring disease are so much alike that it is impossible to distinguish one from the other, without preliminary testing of the trunks and leaf bases for signs of the nematodes responsible for Red Ring disease. This author says "The cause of Bronze Leaf Wilt in Trinidad is, in the majority of cases, due to drought."

Diseases of African Oil Palm.

While a considerable amount of exact knowledge has been gained over the last ten years regarding diseases of Coconut Palms, there is still very little regarding diseases of African Oil Palms.

There are various inconclusive records from West Africa. A species of Ganoderma has been associated with a rot of the trunk; this species is closely related to a fungus common in Malaya e.g. *Ganoderma lucidum*, but the West African fungus

is said to agree best with *Ganoderma tumidum* Bres. The various records from West Africa indicate that a widespread trunk-rot of African Oil Palms is caused by a species of Ganoderma. There is some doubt as to whether one or more species of Ganoderma is concerned. The names *G. tumidum* *G. lucidum* and *G. applanatum* have been applied, but *a priori* it would seem more probable that only one species is parasitic.

A recent report from Sumatra (12) records the finding of *Rigidoporus microporus*, Van Overeem = *Fomes lignosus*, Klotzsch. on Oil Palms. The fungus attacks the soft tissue in the middle of the trunk, producing a "Wet-Rot". The thin roots are not attacked however, and this is probably the reason why the affected palms languish for a long time before dying. A case of *Fomes lignosus*, Klotzsch. on Oil Palms has been found in Malaya during the last year, but though there was a profuse development of fructifications on the dead tissue of the old leaf-bases at the base of the stem there was no evidence to show that the fungus penetrated into the stem tissues.

A bulletin on the now well known "Crown disease" of young Oil Palms has been issued by the General Experimental Station of the A.V.R.O.S. (5). The conclusion in this paper is that "the experiments in pots and in the fields give cause to the supposition, that "Crown disease" is a nutritional-physiological disorder which becomes apparent in a low turgor pressure in the young leaves. The low turgidity (weakness) of the young leaves is the direct cause of the well-known symptoms of the disease."

The Important Factors in the Malayan Problem.

The development of large areas of African Oil Palms on a plantation scale in Malaya has shown that a form of "Bud-Rot" is more common on these palms than on Tall Coconut Palms. This feature led to an experimental investigation of "Bud-Rot" of Coconuts (13); as a result the opinion was expressed that the "Bud-Rot" of African Oil Palms found in Malaya was unlikely to prove an epidemic form. Further experience has shown this opinion to be well justified.

The above investigation brought the writer into close contact with the general problem of "Bud-Rot" of Palms. In Malayan Tall Coconut plantations, a feature known locally

as "Bud-Rot" due to Lightning Strike, is common. In a typical case, a group, usually not more than about 10—12 trees, is affected; two or three of the central trees may be killed outright, and when cut down, these trees usually show the "bud-tissues" in a badly decayed condition, with the usual vile smell. The surrounding trees show symptoms of varying intensity, which, to some extent, support the suggestion of Lightning Strike.

These Lightning Strikes, affecting only a small group of trees were not considered to be serious, but during the last few years, large compact blocks of mature Palms, giving good crops of nuts have been suddenly affected; in one of these blocks some two hundred palms were affected. In these large areas, fifty per cent of the affected trees may die, and in such cases the suggested explanation of Lightning Strike appears inadequate. The explanation of "Bud-Rot" caused by a parasitic organism is equally untenable. A first view of a large affected area is very impressive, (Plates 8, 9 and 10.) and the position would be serious if these outbreaks were more common, or if there was any extension of area, brought about by organisms capable of directly affecting healthy trees. All the evidence up-to-date, indicates that there is no spread or extension from the restricted area in which the affected trees are first seen. The occurrence of these large affected areas of Coconut Palms together with the prevalence of "Bud-Rot" on mature Oils Palm led to the detailed investigations presented in this article.

Early Observations on Diseases of Tall Coconut Palms in Malaya.

In 1923 the position with regard to Epidemic Bud-Rot in Malaya seemed fairly clear; no evidence had been obtained to support the view that any particular organism was responsible and the only alternative was to regard the "Bud-Rot" found in Malaya, as secondary.

The first evidence, which indicated the possibility of stem or root affections was obtained in the Bernam River district in 1922. Numerous diseased trees were found on the estate; the stems, when split, all showed the same symptoms. The stem tissues, while remaining soft and easy to section, were noticably discolored a deep salmon-pink colour, while patches of mustard coloured tissue were prominent intermingled with

the salmon-pink tissue. The whole of the stem tissues in cross-section were involved, and the discolored tissue could be traced from the base of the stem to the crown of the tree, in a cylinder of gradually decreasing diameter in cross-section, characteristic of a slowly progressing organism which had entered through the roots, to progress upwards through the stem. All the trees had suffered severely from "White-ant" attacks. A careful search was made to try to obtain typical specimens of diseased trees, uncomplicated by White-ant attacks, but it was not until some eighteen months later that such specimens were obtained. Since that time, numerous specimens have been found in the different districts in Malaya where Coconuts are grown.

Nowell (8), records in his description of the symptoms of Red Ring Disease that the internal symptoms show the tissues discolored dull-red, or red mingled with mustard yellow; that only in very exceptional cases the discoloration in the stem as a whole is central, and that the diseased zone usually forms a hollow cylinder enclosing healthy tissue inside.

The discolorations of the stem tissues found in the Malayan specimens appear to be similar to those recorded by Nowell, but the distribution of the discolored tissue is central in only very exceptional circumstances in the "Red-Ring" disease, whereas the discolored tissue in Malayan specimens is wholly central, without exception. Nematodes have never been found in Malayan specimens, and it is safe to say that Nematodes are absent, for the worms are of sufficiently large size to be seen under low power magnification. (Plates 1 and 2).

About the same time, 1923, attention was directed to old coconut palms on an inland estate, which were showing a progressive decline. The leaves were gradually dwindling in size; the crop of nuts, moderately good up to the previous year, had diminished to a nil return and single trees were dying off every few months. On cutting and splitting the diseased palms, a very definite hardening of all the stem tissues was a conspicuous feature; the hardening process was so complete that the trees were extremely difficult to cut with axes. The vascular bundles were a dark reddish brown colour and the ground tissue a brownish red colour; the affected tissue could be traced from the base of the stem to near the crown of the tree, in a cylinder of gradually decreasing diameter in cross section, as in the specimens showing the salmon-pink discolo-

rations. Palms not completely dead usually showed about two feet of white, undiscolored tissue beneath the crown, and the bud tissues were healthy. If left standing, the crown of the tree is often blown off by wind.

If such a diseased tree is cut off above ground level, the break is very characteristic; the tissue not cut with the axe tearing apart, leaving the vascular bundles standing erect and stiff to form a "brush-like" arrangement (Plate 3.)

During the period 1923-25, most observations were made on one estate growing some 6000 acres of Tall Coconuts. So-called "Lightning strikes" were frequent, and conformed to the description given above. Many peculiar individual cases of diseased palms have been observed, however.

The first was a well developed palm, 14 years old, with a good crop of nuts. The crown suddenly wilted and the tree was cut down. The roots were healthy; the stem was healthy up to 20ft. followed by a rotten stem section about 4 ft. in length. Above this, the stem and bud tissues were white and healthy. The rotten tissues were soft and slimy, and practically the whole of the stem tissues in cross section were involved. Sections taken to the laboratory showed motile bacteria in large numbers, but attempts to get pure cultures failed. No further cases of this probable bacterial decay have been observed up-to-date.

A similar case to the above, as regards the position of the rotting portion of the stem was obtained recently. The diseased tissue was not slimy and there were no signs of bacteria. Fungal hyphae were prominent in the diseased tissues, but attempts to culture the fungus were unsuccessful.

On 16.5.25 a suspicious "Bud-Rot" Palm, in which the central leaves had collapsed, was examined. The trunk was quite sound, white and healthy, except at the base; from the base to some 18 inches above, faint watery looking zones could be distinguished amongst the whiter, sounder looking tissue. It was thought possible that this might be an early stage of the stem diseases under investigation; hand sections cut and stained in the laboratory indicated the presence of Bacteria in the tissues, and a white bacterium was obtained in culture.

On 26.8.25 a further specimen, 10 years old, was examined. The palm had been blown over. Only the tissues at the collar were discolored, the usual salmon-pink colour; part of the tissues at the collar had been thorougly disorganised

by the larvae of the black beetle, (*Oryctes rhinoceros* Linn.), working in the tissues. The disorganisation of the stem tissues at the base, caused by the larvae, probably accounts for the fall of the palm.

Portions of this palm, showing nice margins were taken and isolations made. The discolored tissue was spongy and moist, and water drops could be squeezed out. A piece of this spongy tissue was cut out, flamed and squeezed between flamed tweezers and the drops of liquid collected in a sterile tube. A loopful of this liquid was utilised to inoculate tubes of Potato Dextrose Agar and Meat Extract Agar. A white Bacterium developed in the culture tubes.

On the same date, on another division of the same estate, groups of diseased palms, or diseased individual palms in close proximity, 8-10 years old, were examined. The early symptoms show a gradual wilting or drying up of the lower two or three whorls of leaves. Young seedling coconuts, used as supplies in the place of diseased trees previously taken out, have died, showing similar symptoms. The affected leaves commonly show rotten spots at the base, and the rot runs well into the stem tissues, so that when treatment is undertaken by cutting off affected leaves, about 1½ inches of diseased stem tissue have to be cut away before healthy stem tissue reached. If the affected leaves are allowed to remain on the tree, the upper leaves become affected in turn and finally the bud is invaded, with the resultant death of the tree.

The rotten spots on the leaf bases are of a slimy nature, and longitudinal crevices usually show on the inside of the leaf bases, suggesting cracking due to strains.

The stem tissues in these affected palms are discolored, but the discoloration is different to, though suggestive of, the common salmon-pink discoloration. Drops of water squeezed out of diseased stem tissue under aseptic conditions were used as inoculum in tubes of Potato Dextrose Agar and Meat Extract Agar. Two different Bacteria, one white, the other pink-colored, were obtained in pure culture; the white Bactrium was the same as that obtained from specimens previously mentioned.

To test the possibility of these Bacteria being the causal agents in setting up this particular type of affection, inoculation experiments were carried out as follows. A dozen three

year old Coconut palms were selected and the inoculations were made by bending back the leaves so far, that, under the strain, small longitudinal cracks appeared in the tissue towards the base of the leaf. In these crevices small quantities of inoculum were inserted on a flattened needle. After ten days, the inoculations appeared to be making good progress, compared with control leaves similarly treated, but uninoculated.

In a further series of inoculations, care was taken not to subject the leaves to too great a strain when pulling them apart; in this case negative results were obtained; the inoculations did not progress.

The results indicate that if the leaf tissues are placed under sufficient strain, both these Bacterial species are capable of making progress in the tissues. The suggestion that strains and stresses, set up under any particular conditions, may initiate this particular type of affection was made above. In these affected trees, the lower leaves of the crown stand almost vertically, and it appears possible that normal development is stopped at an early stage and that these lower leaves do not break away to assume the more natural horizontal position. The continued development and expansion of the central core of leaves may then produce sufficient strain upon the outer lower leaves as to cause the vertical cracks usually found on the affected leaf bases. Alternatively, the cracks may result from the drying out of the affected tissues; although the inner, external surface of the affected leaf-bases is always moist and slimy, the internal tissues are quite dry. Though different explanations may be given for the origin of these cracks, their appearance allows direct entry for a variety of organisms, for numerous species of Fungi and Bacteria are always present in the vegetable debris which accumulate in the leaf axils.

Further work on a backward 25 acre field on this estate showed many interesting features. This field was separated by a two foot drain from a normal yielding field and no difference in soil type was noticeable. The trees in the backward field were obviously suffering from some form of degeneration. A typical tree shows an obviously thin crown, with some five or six of the lowest leaves hanging against the stem; these could be pulled off easily. The remainder are small in size and the lower ones show signs of various inju-

ries, the leaf stalks commonly being bent in the middle. Each leaf, taken off separately, shows the strainers very wet, discolored blackish brown, the discolored tissue often running into the tissues at the base of the leaf. As the leaves are detached, from below upwards, the discolored strainer tissue becomes drier, and the slimy appearance less prominent. The strainers were discolored right up to the youngest opened central leaf, but in the most recently developed leaves, the discoloration never reached the leaf base tissue. The cabbage and unopened central leaves were quite healthy and white.

The palm, showing the symptoms described, compared favourably in appearance with neighboring palms. The roots were healthy. The stem was cut two feet above ground level and showed the reddish brown discoloration of the Vascular Bundles; the ground tissue between the Vascular Bundles was quite white, but was very brittle and highly lignified. Splitting of the trunk showed the reddish-brown discoloration of the Vascular Bundles up to eight feet high.

Another palm, next in the row to the one described above, showed a more advanced stage, judging from the appearance of the crown. The examination was conducted in the same way; the first cut at two feet above ground level showed no discoloration in the Vascular Bundles; glancing cuts made through the roots to expose the woody tissues at the base of the stem showed the reddish discoloration entering the stem from the roots.

A third tree, with the disease well advanced, judging from the leaves, all of which were much reduced in size, was next examined. There was no discoloration of stem tissues, except at the very base, where the roots entered the stem.

In the series of observations described above attention is drawn to:—

(*a*) A soft salmon-pink discoloration of the stem tissues.

(*b*) An affection showing hardened lignified stem tissues.

(*c*) A single case of a probable Bacterial affection of the Stem tissues, uncomplicated by the question of root or Bud affections.

(*d*) A similar type of stem affection, the probable cause being a fungus.

Attention is also directed to stem and leaf affections with which a white and a pink Bacterial species are associated and evidence has been obtained to show that, under certain conditions, these organisms are capable of penetrating into the tissues. The White Bacterium seems to be constantly associated with these little understood affections of Coconut palms.

As a result of observations on a leaf disease of Dwarf Coconuts, interesting evidence has been obtained which leads to a logical explanation of the features noted in the backward 25 acre block mentioned above. Attention was directed to a fungus which is commonly found on many types of palms growing on the inner surface of the leaf base, close to its junction with the stem. The white strands of this fungus are typical of a species of *Marasmius*.

The palms in the block have improved since 1926, but in another block some distance away, the palms are retrogressing as described. The palms show several lower leaves hanging against the stem and when these are pulled off, the typical white mycelial strands of a *Marasmius* sp. are commonly found. The significance of this finding will be expounded below.

PART I. (B).

Marasmius Palmivorus (Sharples). A Cause of Palm Diseases.

On the inside of the leaf bases of many palms, white mycelial strands are commonly found. (Plates 4 and 5). These strands have been found to be associated with a small, usually pink-capped *Marasmius* sp. Specimens of this fungus have been submitted to the Imperial Bureau of Mycology for identification, and the report from the Director says that the fungus is undoubtedly a new species. The name *Marasmius palmivorus*, Sharples, is suggested and a description is given below.

This particular fungus was first reported causing damage to bunches of Oil Palm fruits in Malaya, in 1924 (14). Later, this fungus was reported to be causing damage on two year old Coconut Palms. Usually, the fungus appears to be growing saprophytically at the base of the leaf, where the

leaf is closely adpressed to the stem. In 1924, when investigating this fungus on Oil Palm fruit bunches, the mycelial strands could be found on the leaf bases of practically all the palms examined. It is so common, under certain conditions, on the leaf bases of Oil Palms and Dwarf Coconut Palms that if proof can be advanced of the possible parasitism of this fungus, it would be necessary to take immediate measures to prevent material damage being done.

M. Palmivorus on African Oil Palms.

In the report for 1924 (14) the writer stated:—"While commonly present (on Oil Palms) no damage is done if the fungus remains in its usual place on the leaf bases. Recently, one case has been observed where the fungus grew up over the mature fruit-bunches and rendered them useless for oil production. The common presence of this fungus on the palms and the possibility of the parasitic tendency becoming more pronounced, makes careful supervision necessary. It appeared that the trouble might have originated owing to the numerous, non-fecundated bunches being allowed to remain and disintegrate on the tree; usually a few fruits are present in such bunches, and as the fungus under consideration appears to be the chief agent concerned in the disintegration of the non-fecundated bunches, it is possible for this organism to become gradually accustomed to growing into, and to attack fully matured bunches. The suggestion to remove the non-fecundated bunches was made and carried out and there has been no further recurrence". No further recurrence refers to this particular estate; this year similar phenomena have been observed on two other Oil Palm estates. (Plate 6).

From these observations made in 1924, it appeared probable that, given a suitable and plentiful nidus of decaying vegetable matter, which would promote strong growth of the fungus, there were distinct possibilities that this fungus might exhibit a strong tendency towards a parasitic habit. This view was supported by the attack on the two year old Coconut Palms mentioned above.

M. Palmivorus on Dwarf Coconuts.

An attack of this fungus on Dwarf Coconuts has been investigated this year (1928). The typical Marasmius strands were found in profusion on the leaf bases of affected trees.

The palms were planted on peaty land, and as they appeared backward, it was first suggested that soil conditions were mainly responsible. Later, the majority of the fields improved considerably but numbers of the palms on which the fungus was growing vigorously were still backward. These backward palms had a typical appearance. At the base of the crown of leaves, a confused mass of dead leaves and strainers, still attached to the tree, formed a tangle of disintegrating vegetable tissue. The fungus was prominent in the rotting tissue and there seems every reason to suspect that this disintegrating mass of tissue is the source from which the fungus makes its way on to the leaf-bases of the functioning leaves. There appears to be a premature falling of the leaves on these affected trees, the spike of nuts subtended by the lower leaves being unsupported, or propped up by artificial means. On the functional leaves, the fungus remains confined to the base of the leaf. This can be accounted for by the fact, that most species of Marasmius require a plentiful supply of moisture for growth and development, and in the enclosed spaces formed by the union of leaf with stem, a plentiful supply of moisture is assured. Support for this statement is forthcoming by the behaviour of the fungus when leaf-bases showing mycelial strands are placed under a dropping tap; the fungus then grows and fruits luxuriantly. (Plates 5 and 7).

Marasmius Palmivorus on Tall Coconut Palms.

As stated above, "Lightning Strike" so-called, is believed to be the cause of the loss of numerous mature palms on Malayan Coconut Estates; authentic cases, in which the explanation can be established without doubt, are not common.

When only small groups of palms, 10-12 in number are affected, the explanation of "Lightning Strike" is accepted in this article. On numerous occasions, since 1923, groups contained larger numbers of palms, 50-200 trees in a solid block, have become affected so seriously, as to necessitate the immediate cutting-out of large numbers of dead or dying palms, the latter affected so seriously, as to preclude all hopes of recovery. The explanation of "Lightning-Strike" appears inadequate to meet such cases.

These large outbreaks, have taken place in areas, the palms on which are fully mature, over 15 years old, and bearing excellent crops of nuts. When the dead and dying palms are cut down and the stems split for examination, the specimens show the symptoms of salmon-pink disease with

soft stem tissues, and the hardened lignified symptoms described above, in about equal numbers. Some cases showed a mixture of symptoms, i.e. an outer ring of discolored salmon-pink, soft tissue, surrounding a hard lignified core, or *vice versa* in fewer cases.

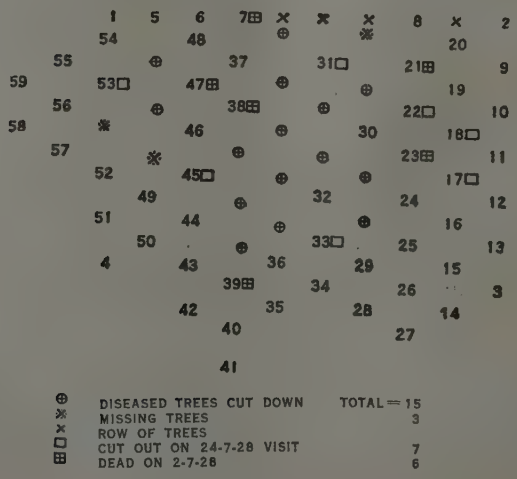
Since the first outbreak was observed, many others have been examined. These have occurred in all parts of Malaya where Tall Coconut Palms are grown on a large scale. The estate on which the first large outbreak was observed in 1923 had another larger outbreak, a few hundred yards away from the earlier one, three years later; in this 1926 outbreak some two acres of palms were affected.

Large outbreaks have been observed in the districts of Banting, Bagan Datoh, Bernam River, Province Wellesley and Benut in Johore.

This year (1928) one of these large groups has been under close study, 68 trees being marked and individual records taken at approximately monthly intervals.

In this plot 68 trees were numbered on the 15-5-28. A further 15 trees, badly affected, had been cut out previously. The first visit was actually made on the 8-5-28, when only 7-8 trees had been cut out (See Plan).

PLAN OF AFFECTED PLOT



The first individual records were taken on the 15-16th May/28. The trees in the affected block show varying symptoms. The definite symptoms were classified as under:—

(1) Stem Bleeding—(a) Profuse. (b) Slight. (c) Absent.

(2) State of lower whorls of leaves—whether (a) broken or (b) hanging.

(3) State of middle whorls of leaves—whether (a) broken or (b) not broken.

(4) General condition of Crown.

(5) Condition of stem tissues—

(a) Cortex discolored or not discolored.

(b) Whether Vascular Bundles discolored or otherwise.

(6) Number of nuts.

Some explanation of the above symptoms is, perhaps, advisable. Many of the trees show a brownish-red "bleeding" from cracks in the bark. In some cases the bleeding is found almost over the whole length of the stem.

Broken leaves are found on affected trees and the break may occur in two different ways. In one case the break occurs about two feet away from the distal extremity of the leaf, and this portion of the leaf hangs down, the lower portion attached to the stem remaining green. "Tipped" is a convenient term for such leaves. The second break is one which takes place about the point where the basal leaf pinnae join the petiole, about 3—5 feet away from the stem, and the whole of the leaf carrying the leaflets hangs down. "Broken" is a convenient term in contradistinction to "tipped". Leaves breaking away from the stem at the base but remaining attached and hanging against the stem will be termed "hanging". (Plates 8, 9 and 10).

Both lower and middle leaves may be "tipped" or "broken". Lower leaves are usually "hanging" or "broken" and less seldom "tipped"; middle leaves are commonly "tipped" less seldom "broken". The terms describing the remaining symptoms are self-explanatory.

The position on the first visit on the 15-5-28 is given in the table below (Table I). Further visits were made on the 12-6-28, 24-7-28 and the final observations for this paper on 2-10-28.

TABLE I.

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No. of nuts.	Remarks.
A 1	None	Two broken	None	Good	No discoloration	—	(2) Two middle leaves broken. (3) One middle leaf broken. (4) Two broken, one hanging.
A 2	None	Two broken	One broken	Good	No discoloration Cortex healthy	Good	(2) Two lower and three middle leaves broken. (3) As before. (4) As before.
A 3	None	None	None	Good	Cortex white	Excellent	(2) One middle leaf tipped. (3) As before. (4) As before.
A 4	—	—	—	—	—	—	(3) A. 1. (4) „ „
A 5	None	Two broken on inside	None	Good	V. Bundles slightly discolored	Good	(2) Lower broken leaves missing. (3) As before. (4) Improved.
A 6	Slight at base	One broken	None	Poor	V. Bundles slightly discolored	Not too good	(2) Three lower leaves tipped. (3) As before. (4) One hanging—borers in stem.
A 7	Bleeding up to 15 ft.	None	None	Good	No discoloration	Moderate	(2) Three lower leaves hanging and dead. Two lower leaves tipped. (3) Four hanging lower leaves. (4) Dead.
A 8	Bleeding—15 ft.	Drooping. one broken	None	Good	Slightly discolored	Good	(2) Three lower leaves drooping and dead. (3) Two lower half leaves still attached. (4) Improved crown and nuts good.

Remarks column: (2) = visit made on 12- 6-28.
(3) = „ „ „ 24- 7-28.
(3) = „ „ „ 2-10-28.

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No. of nuts.	Remarks.
A 9	None	Two broken	None	Good	Cortex white Slightly discolored	Good	(2) Two lower and three middle leaves broken. (3) Only one hanging. (4) One lower and one middle leaf tipped.
A 10	None	None	None	Good	Cortex white Slightly discolored	Poor	(2) —— (3) —— (4) As before.
A 11	None	Two broken	Two broken	—	Cortex badly discolored No discoloration of V. B.	Good	(2) Three lower and two middle leaves broken. (3) One lower tip broken. Two lower leaves attached. One middle tip broken. (4) Improved.
A 12	None	None	None	Good	Cortex white	Excellent	(2) —— (3) —— (4) As before.
A 13	None	None	None	Good	Cortex healthy No discoloration	Poor	(2) —— (3) —— (4) As before.
A 14	None	One broken	None	Good	Cortex healthy	Excellent	(2) —— (3) Two lower leaves hanging one tipped lower leaf. (4) Improved.
A 15	None	Three hanging not broken	None	Good	Cortex healthy No discoloration	Good	(2) —— (3) —— (4) As before

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts.	Remarks.
A 16	None	None	Four broken	—	Cortex discolored V.B. not discolored	Good	(2) Two lower leaves hanging. Five middle leaves broken. (3) Four lower leaves hanging. One middle leaf hanging. (4) Improved. One hanging, no new ones broken.
A 17	Slight at 5 ft.	Hanging. one broken	None	Good	Cortex badly discolored V.B. not discolored	Poor	(2) Three middle leaves broken. (3) Dead—to be cut out.
A 18	Slight up to 12 ft.	Bent and broken.	½ doz. upper leaves standing up stiff & straight	Poor	Cortex badly discolored V.B. not discolored	Poor	(2) As before, another middle leaf broken. (3) Cut out.
A 19	None	Hanging leaving few upper leaves standing up-right	—	Poor	Cortex healthy V.B. not discolored	Good	(2) All lower leaves hanging—one middle leaf broken. (3) One middle leaf hanging. (4) Improved. Two lower leaves hanging; one middle broken.
A 20	Slight	Three broken	None	Not too good	Cortex discolored V.B. discolored	Poor	(2) Four lower leaves hanging one middle leaf tipped. (3) Whole of lower leaves hanging: few top leaves standing. (Cut out. Letter 9-8-28.)
A 21	Profuse up to 10 ft.	One hanging	One broken	—	Cortex slightly discolored V.B. not discolored	Excellent	(2) —— (3) As before—with central leaf broken. (4) Dead. Cut out.

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts.	Remarks.
A 22	Bleeding up to 10 ft. Profuse up to 6 ft.	None	Five broken	—	Cortex badly discolored V.B. not discolored	Poor	(2) One extra middle leaf tipped. (3) Dead. (Cut out Letter 9-8-28)
A 23	Profuse up 7 ft.	Hanging but not broken	Two broken	—	Cortex badly discolored V.B. not discolored	Good	(2) Four middle leaves broken. (3) As before. (4) Dead to be cut out.
A 24	Profuse up 15 ft.	One broken	Two broken	—	Cortex badly discolored V.B. not discolored	Good	(2) —— (3) As before. (4) Improved.
A 25	Slight up 15 ft.	Two hanging	Horizontal	Crown open	Cortex very badly discolored V.B. not discolored	Fairly good	(2) One lower leaf tipped (3) Three lower leaves hanging one broken at tip. (4) One lower leaf hanging and one middle leaf tipped, borers entering.
A 26	Bleeding up 6 ft.	One broken	Two broken	—	Cortex very badly discolored V.B. not discolored	Poor	(2) Four middle leaves broken one lower leaf hanging. (3) Three lower leaves hanging. Two middle leaves broken. (4) As before.
A 27	None	None	One broken	Good	Cortex healthy	Good	(2) —— (3) As before. (4) „ „

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts.	Remarks.
A 28	None	One broken	Two broken	—	Cortex healthy	Good	(2) —— (3) As before. (4) Improved.
A 29	Slight at base	All hanging	One broken	—	Cortex badly discolored V.B. not discolored	Excellent	(2) —— (3) As before. (4) „ „
A 30	Slight	One hanging	Three broken	Crown open and poor	Cortex very badly discolored V.B. discolored	Good	(2) As before but central shoot gone. (3) As before. (4) Special new centre shoot appearing.
A 31	None	All hanging one broken	One broken	Poor	Cortex discolored V.B. not discolored	Poor	(2) Crown disappearing rapidly. (3) Cut out.
A 32	None	One hanging Must have fallen	One broken	Poor	Cortex badly discolored V.B. not discolored	Poor	(2) Centre shoot gone. (3) As before. Cut out (Letter 9-8 28).
A 33	Slight up to 6 ft.	One hanging Two broken	None	Poor and thin	Cortex white V.B. not discolored	Poor	(2) Crown going rapidly no nuts. (3) Cut out.
A 34	None	None	One broken	—	Cortex healthy	Good	(2) —— (3) All lower leaves and nearly all middle leaves broken. Still got good No. of nuts. (4) As before.

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts.	Remarks.
A 35	None	Two hanging	None	Good	Cortex healthy	Good	(2) —— (3) As before. (4) „ „
A 36	Profuse	One broken and rest fallen	None	Thin and open	Cortex badly discolored V.B. not discolored	Good	(2) ——appearance improved. (3) As before ; one middle leaf tipped. (4) As before but borers entering.
A 37	Fairly profuse up to 12 ft.	Two broken	None	Compact and good	Cortex discolored V.B. not discolored	Good	(2) One lower leaf tipped and some hanging. (3) As before (4) „ „ but borers entering stem.
A 38	Slightly up to 12 ft.	All hanging and dead	Three broken	Good	Cortex discolored V.B. not discolored	Poor	(2) —— (3) As before. (4) Dead to be cut out.
A 39	Very slight bleeding	One hanging	One broken	Good	Cortex discolored V.B. not discolored	Poor	(2) Improved. (3) As before. (4) Dead to be cut out.
A 40	None	Hanging slightly	Three broken	Good	Cortex healthy	Good	(2) Four broken middle leaves. (3) Lower leaves hanging one middle leaf broken. (4) Six middle leaves hanging or broken.
A 41	None	One broken	None	Good	Cortex healthy	Good	(2) —— (3) As before. (4) „ „

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts.	Remarks.
A 42	None	None	None	Good	Cortex healthy	Good	(2) —— (3) Two lower leaves hanging. (4) Improved
A 43	None	One broken	None	Good	Cortex badly discolored V.B. discolored	Good	(2) Two lower leaves broken. (3) As before. (4) One lower leaf hanging
A 44	Slight	None	One broken	Good	Cortex badly discolored V.B. discolored	Good	(2) —— (3) As before. (4) One lower leaf tipped.
A 45	Slight	One hanging	One broken	Fairly good	Cortex discolored V.B. not discolored	Poor	(2) Two broken middle leaves. (3) Dead. Cut out (Letter 9-8-28)
A 46	Slight	None	None	Good	Cortex discolored V.B. not discolored	Excellent	(2) —— (3) Two lower leaves hanging. (4) Improved.
A 47	Profuse up to 30 ft.	None	Three middle leaves. One central leaf.	Thinning out	Cortex discolored V.B. slightly discolored	Good	(2) More middle leaves broken. (3) As before but upper and central leaves broken. (4) Dead. Cut out.
A 48	None	None	Five broken	Good	Cortex healthy	Good	(2) —— (3) Two lower and two middle leaves broken. (4) As before no fresh leaves affected.

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts.	Remarks.
A 49	Profusely	None	None	Very good	Cortex very badly discolored V.B. not discolored	Good	(2) One broken leaf. (3) Two lower leaves drooping. One middle leaf tipped. One broken middle leaf. (4) Improved. One middle leaf tipped.
A 50	Slight	Two hanging	None	Good	Cortex discolored V.B. not discolored	Good	(2) Improved (3) As before. (4) „ „ borers entering stem.
A 51	None	None	One broken	Good	Cortex healthy	Good	(2) —— (3) As before (4) „ „
A 52	None	None	None	Good	Cortex not discolored	Good	(2) —— (3) One lower leaf hanging and one tipped. (4) As before.
A 53	None	One hanging	Two broken	Good except for sides where leaves are broken	Cortex discolored V.B. not discolored	Good	(2) Broken leaves disappeared. (3) Dying rapidly. All nuts fallen. Cut out (Letter 9-8-28.)
A 54	None	None	None	Good	Cortex healthy	Good	(2) —— (3) As before (4) „ „
A 55	None	Three hanging	Two broken	Good	Cortex not discolored	Good	(2) —— (3) Two middle leaves broken. (4) Two lower leaves hanging—improved.

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves	Middle leaves.	General condition of crown	Stem tissues.	No of nuts.	Remarks.
A 56	Slight	Two broken and two hanging	Three broken	Good	Crotex discolored V. B. not discolored	Good	(2) —— (3) Five lower leaves hanging. One middle leaf broken. (4) One lower leaf hanging and one broken. Improved.
A 57	None	One broken	None	Thin	Cortex healthy	Good	(2) No broken leaves. (3) As before. (4) Improved.
A 58	None	One broken	None	Good	Cortex healthy	Good	(2) —— (3) As before. (4) One lower leaf hanging.
A 59	None	One hanging	None	Good	Cortex not discolored	Good	(2) —— (3) As before. Two lower leaves hanging. (4) As before.
A 60	Slight	All hanging	Two broken	Otherwise Good	Cortex discolored V. B. not discolored	Good	(2) Three middle leaves broken. (3) All lower leaves hanging. Three middle leaves broken. (4) Six leaves hanging.
A 61	Slight	None	Two broken	—	Cortex discolored V. B. not discolored	Good	(2) One hanging and four broken. (3) One lower leaf half attached. Two middle leaves hanging one central leaf hanging. (4) One middle leaf broken.
A 62	None	None	One broken		Cortex not discolored	Poor	(2) —— (3) As before. (4) Two lower leaves hanging.
A 63	None	None	One broken	Good	Cortex not discolored	Good	(2) —— (3) Three middle leaves broken. (4) As before.

TABLE I.—(*Contd.*)

Tree No.	Stem bleeding.	Lower leaves.	Middle leaves.	General condition of crown.	Stem tissues.	No of nuts	Remarks.
A 64	None	One hanging One broken	None	Good	Cortex healthy	Good	(2) Two broken and one hanging. (3) One hanging and one broken. (4) As before.
A 65	Profuse	Hanging leaves one broken	Three broken	Open crown	Cortex discolored V.B. not discolored	Good	(2) Three broken and one tipped. (3) One middle leaf tipped. Lower and middle leaves drooping. (4) Leaves drooping; but none broken.
A 66	None	None	One broken	Good	Cortex healthy	Good	(2) —— (3) As before. (4) " "
A 67	Slight	Two broken	None	Good	Cortex healthy		(2) —— (3) One lower leaf hanging. One middle leaf broken (4) Two lower leaves hanging and one middle leaf tipped.
A 68	Slight	Two broken One hanging	None	Good	Cortex discolored V.B. not discolored	Good	(2) —— (3) Two lower leaves hanging. (4) Improved.

On the second visit the Manager reported that no apparent change had taken place and a general survey confirmed this impression. When the individual records were taken, it was found that a very definite sequence of events was in progress. There had been no extension in area. The sequence of events was shown by trees noted on the previous visit with "hanging" and "broken" lower leaves and with "broken" or "tipped" middle leaves; these trees were in a similar condition, except that the bases of the trees were marked by numerous lower "broken" leaves which had fallen since the last visit. (Plate 11). It is evident that there is a rapid throwing-off of "hanging" and "broken" lower leaves; the "broken" middle leaves now become the lower leaves and, coincidently, fresh leaves in the higher whorls become "broken" or "tipped". A rapid defoliation combined with the breaking of middle leaves takes place, and after a time the central shoot collapses, but not because of the rotting of the bud. A later visit showed the cause of the collapse of the central shoot. Several trees with collapsed central shoots were cut down. About two feet below the crown, the stem tissues were black and disintegrated; in the disintegrated tissue dozens of grubs of the Rhinoceros beetle, (*Oryctes Rhinoceros*) were found. The disintegration of the stem tissues caused by these caterpillars would prevent the ascent of water, and the soft central leaves, dependent for their strength largely on the turgidity of the cells forming the tissues, naturally collapse. The bud-tissues are quite healthy if the tree is examined soon after the collapse of the central leaves.

Below a tabulated list (Table II) is given of some of the significant trees which support the explanation offered. For example, Tree No. 26 is found on the first visit with one broken lower leaf and two broken middle leaves. The next visit shows one hanging lower leaf, four broken middle leaves, the broken lower leaf having fallen. The next visit shows three hanging lower leaves and two broken middle leaves. The latter have broken since the last visit; the four broken middle leaves of the previous visit were found at the base of the tree, and the hanging lower leaves represent the leaves in the same whorl which were unaffected.

TABLE II.

Tree No.	Lower leaves on 12-5-28.	Lower leaves on 12-6-28.	Lower leaves on 24-7-28.	Middle leaves on 15-5-28.	Middle leaves on 12-6-28.	Middle leaves on 24-7-28.
1	Two broken	——	——	None	Two broken	One broken
2	Two broken	Two broken	As before	One broken	Three broken	As before
3	——	——	As before	——	One tipped	As before
5	Two broken	None-Lower broken leaves fallen	As before	None	None	None
6	One broken	Three tipped	As before	None	None	None
7	None	Three hanging-Two tipped	Four hanging	None	None	None
9	Two broken	Two broken	One hanging	None	Three broken	None
11	Two broken	Three broken	One tipped - Two hanging	Two broken	Two broken	One tipped
14	One broken	None	Two hanging - one tipped	None	None	None
16	None	Two hanging	Four hanging	Four broken	Five broken	One hanging
17	All hanging One broken	Cut out		None	Three broken Cut out	

TABLE II.—(*Contd.*)

Tree No.	Lower leaves on 12-5-28.	Lower leaves on 12-6-28.	Lower leaves on 24-7-28.	Middle leaves on 15-5-28	Middle leaves on 12-6-28.	Middle leaves on 24-7-28.
20	Three broken	Four hanging	All hanging - Cut out	None	One tipped	Cut out
23	All hanging	As before	As before	Two broken	Four broken	As before
26	One broken	One hanging	Three hanging	Two broken	Four broken	Two broken
34	None	As before	All hanging	One broken	As before	All broken
40	None	None	All hanging	Three broken	Four broken	One broken
48	None	As before	Two broken	Five broken	As before	Two broken
49	None	As before	Two hanging	None	One broken	One tipped - One broken
53	One hanging	None	Dying rapidly	Two broken	None	
61	None	One hanging	As before	Two broken	Four broken	Two hanging-Central Shoot fallen
63	None	As before	As before	One broken	As before	Three broken

The observations on Dwarf Coconuts (c.f. above) led to an examination of the leaf bases for the possible presence of *M. palmivorus*. The typical Marasmius strands were quickly found and this fungus was found to be common on the leaf bases although the weather conditions for several months had been decidedly dry. Specimens were taken to the laboratory, placed under appropriate conditions and the typical fruit bodies were quickly produced.

The visits made on the 24.7.28 and 2.10.28 support fully the observations made on the 12.6.28 (see Table 1). The affected palms with leaves hanging and broken suffer a rapid defoliation owing to the fungus growing into the leaf-base tissues at the junction of the leaf with the stem. When a lower leaf is pulled off which shows the white strands on the inside of the leaf base, and the tissues exposed by the break are examined, the hyphae of the fungus are found penetrating into the leaf-base tissue from the upper surface. The fungus hyphae show in the tissues to a depth of ½″ from the upper surface, across the full width of the leaf base; as a result the tissues of the leaf base are weakened at the point of attachment with the stem, and the weight of the leaf causes rupture at this weakened point. At the present time the writer is not convinced that *M. palmivorus* is the only fungus which works in this manner; a *Thielavia* sp. is commonly found in these cases and is suspected of acting in a similar way. But *M. palmivorus* is by far the commonest fungus, and as in the case of Oil Palms and Dwarf Coconuts, becomes more prominent as larger amounts of dead and decaying tissue in the shape of hanging leaves and strainers becomes available. The trees suffering rapid defoliation are commonly attacked by beetles near the crown and succumb rapidly; even if not attacked by beetles the continual shedding of the leaves results in decreased protection of the bud-tissues; these become invaded by saprophytic organisms and the tree becomes a total loss.

The symptoms of slight or profuse stem bleeding cannot be definitely connected up. These palms are subject to attacks by a small boring beetle, *Saprosites pygmaeus* Har. which bores into the stem tissues. The discolored cracks in the bark from which the reddish exudation makes exit, are surrounded by small areas of blackish cortical tissue. Isolations from such tissue resulted in the growth of a fungus with yellowish mycelium on Potato Dextrose agar; this fungus is a species of *Cytosporella*; preliminary inoculations with this

fungus indicate that the fungus can penetrate into the cortical tissue, but typical bleeding has not yet been obtained. Up-to-date none of the trees suffering from borer attacks have died.

The casualty list in this particular area was much heavier than anticipated on the first visit. There are 35 trees missing in the block, of which 31 can be definitely accounted for, practically 50% casualties. (See Plan). Now a logical explanation of the cumulative effects can be offered, it should be possible to prevent the death of some of the trees which succumbed after the second visit on the 12.6.28, even though there is still doubt regarding the initiating cause. The methods to be adopted will be discussed later.

The evidence obtained strongly supports the view that *M. palmivorus* is a factor of considerable importance in the causation of diseases of various palms in Malaya. In the case of African Oil Palms, the evidence is so clear cut that the writer is prepared to forsake a cautious attitude, and even in the absence of inoculation experiments to regard this fungus as the cause of a serious disease. This fungus is causing serious trouble on one African Oil Palm estate at the present time, and it is difficult to suggest inexpensive remedial measures which would undoubtedly aid in control.

The position is similar in regard to Dwarf Coconuts. *M. palmivorus* is responsible for considerable damage to these palms under certain conditions.

The position with regard to the problems in Tall Coconut plantations is not so clear-cut, but the collateral evidence is so strong that the writer has no hesitation in considering that the proper understanding of the work of this fungus, will prove to be the key to the solution of the disease problems on Tall Coconut Estates in Malaya. Two undoubted cases of Lightning Strike, conforming to the description given previously, have been investigated recently and the sequence of events is exactly the same as that given for the large area in which the disease phenomena are fully described above. The recent work on backward areas of Tall Coconut Palms fully supports the observations, and conclusions derived therefrom, given above. The initiating cause in these disease troubles, is still problematical, but it is now possible to visualise individual problems which can be worked upon with but little risk of being side-tracked by phenomena which are unrelated to the particular problem.

It is of interest to mention here that many species of Marasmius are definitely associated with diseases of cultivated crops. Nowell (9) says, "Several species (of Marasmius) occur in the West Indies about the bases of the shoots of grasses, including sugar-cane, and are well-known in connection with root diseases of that plant. Others occur on the leaf sheaths of banana, where they also have a connection with disease, and the same or similar species are found on the "strainer" of the coconut palm. These are at most, rather weakly parasitic. A much more definite parasite is *Marasmius perniciosus*. Stahel, the cause of the Witch Broom disease of cacao in Surinam".

The above statements are quoted in support of the experience gained in Malaya and it may be possible that further investigation in the West Indies may disclose results which will have a probably significant degree of similarity. *M. palmivorus* has been found associated in Malaya with a leaf and leaf-sheath disease of one particular banana variety, known as *"Pisang Rajah Udang".

The leaf strainer tissue on affected Dwarf Coconuts (Plate 5) and Tall Coconuts is often a thick mat of *M. palmivorus* mycelium. The "weakly parasitic" habit has been brought forward conspicuously in the Malayan investigations. But for the very definite capacity to cause disease, as illustrated by the attacks of this fungus on African Oil Palms and Dwarf Coconuts, it is doubtful whether its potentialities in accelerating the progress of affections of Tall Coconut Palms would have been realised.

Description of the Fungus.

The growth habit of *M. palmivorus* is the same on African Oil Palms, Dwarf Coconuts and Tall Coconuts. The prominent fungus strands are found growing over the leaf-bases on the upper surface where the leaf bases are closely adpressed to the stem (Plates 4 and 5). Under these conditions, the fungus is mainly saprophytic, growing profusely in the presence of abundant moisture.

The strands are mainly white in colour, though there is often a definite pinkish colour. They often form fan-shaped patches on the surface of the leaf bases (Plates 4 and 5) and the fruit bodies arise in close association with the strands.

*Pisang — Local Malay name for Banana.

The fruit bodies are very variable both in colour and size; the variations are entirely dependent on the presence of abundant supplies of moisture. When leaf bases of Dwarf or Tall Coconuts, or affected oil palm fruit showing the white mycelial strands are brought into the laboratory, the fructifications appear only in the presence of abundant moisture and free air circulation. Numerous other fungi such as Thielavia sp. in Coconuts and *Schizophyllum commune* Fr. on rotting oil palm bunches, are commonly present. If diseased Coconut leaf bases showing the white strands of *M. palmivorus* are placed under bell-jars the usual order of appearance of the various fungi is as follows:—First there is a profuse development of a thick sward of hanging, greyish mycelium, intermingled with which are numerous spores of a *Thielavia* sp. This grows for 4-5 days and is followed by a magnificient crop of a large *Coprinus* sp. The fructifications of *M. palmivorus* do not appear under these conditions.

If affected leaf-bases showing the strands of *M. palmivorus* are placed under a dropping tap, freely exposed to the air, there is a profuse development of fructifications of *M. palmivorus* in about ten days, while the fungi mentioned in the preceding paragraph do not become prominent (Plates 12, 13 and 14). The fructifications of *M. palmivorus* continue to develop for several months in the presence of abundant moisture, and free circulation of air.

When moisture is somewhat limited, the fructifications of *M. palmivorus* are comparatively small in size. The upper surface of the "cap" is Eosine-pink when young, fading to shrimp-pink as they age (Plate 17). The "cap" is about $\frac{1}{2}$-$\frac{3}{4}$" in diameter when full grown, smooth, convex, margin incurved when young. Gills on the under surface of the "cap" are pure white, attached to the stem, but in old specimens become slightly detached. No cross veins, distant, fairly thick. Stalk $\frac{1}{2}$-$\frac{3}{4}$" high, white, smooth, solid, slightly bulbous at base; the swollen basal part often shows the same colour as the upper surface of the "cap" when young. Single or caespitose. Spores hyaline, 10u—5.5u slightly beaked when mature.

In the presence of abundant supplies of moisture the above description is quite inaccurate. The cap loses practically all colour and is white and transparent. The cap may grow to measure 2-3 ins. in diameter and shows many con-

volutions with edges upturned. (Plates 14 and 18). The stalk may increase in length up to about 1--1¼ ins. and the bulbous base usually retains some indication of a pink colour.

The same variations are met with in the field during very rainy weather.

Spore prints of *M. palmivorus* are easily obtained in the usual way and pure cultures were set up by transferring a few spores on to slants of Potato-Dextrose Agar. Pure cultures from fructifications developed on Oil Palms, Dwarf Coconuts, Tall Coconuts and a variety of Banana will be studied when time permits. Pure cultures have also been obtained from diseased leaf base tissue of Dwarf and Tall Coconuts.

The technical description of *M. palmivorus* is given below:—

Marasmius Palmivorus n.s.

Under dry Conditions.—Pileus ½-¾ in. across: umbonate smooth, slightly striated. Upper surface Eosine Pink when young—Shrimp-Pink later (Ridgeway) glabrous. Margin incurved when young. Gills pure white: attached when young but in old specimens becoming slightly detached from stalk: no cross veins: thick, distant. Stalk ½-¼ in. high. White, glabrous, solid, slightly bulbous at base; the bulbous base often shows same colour as upper surface of young pileus: Single or Caespitose. Spores hyaline, 10u 5.5u. Slightly beaked when mature.

Under moist Conditions.—Pileus white and transparent—when young shows traces of brownish-red colour. 2-3 in. across. Much convuluted with upturned edges. Stalk 1-2 in. high. Bulbous base usually retains traces of pink colour.

White mycelial strands often forming fan shaped patches on leaf bases and Fruit Bunches of *Elaeis Guineensis* Jacq. and on leaf bases of Dwarf Coconuts and Tall Coconuts (Cocos nucifera).

Control Measures for M. Palmivorus.

The life-history of this fungus indicates the lines for control measures. Accumulations of dead and decaying vegetable material must be avoided. Fructifications are prominent only in wet weather, so that during wet periods greater

care must be taken, if spread by spores is to be retarded. The measures to be adopted are different in the various cultivations according to the different growth and fruiting habits of the palms.

Control Measures on Oil Palm Plantations.

Spraying methods cannot be recommended on Oil Palms, because of the danger of killing the male and female flowers and so preventing production of fruit. Apart from this, the growth habit of the fungus on Oil Palms is such, that it is impossible to conceive of the spray reaching the mycelial strands in the leaf axils and inner portions of affected fruit bunches.

As spraying cannot be recommended, the only methods that can be adopted are the usual sanitation methods, designed to clear away vegetable debris and decrease atmospheric humidity in the places where the fungus is growing strongly.

An Oil Palm showing badly infected, mature fruit bunches, should be cleaned up by pruning the leaves subtending such fruit bunches and the fruit bunches must be cut out. All the vegetable tissue showing the white strands of the fungus should be burnt if possible; this would necessitate the entire destruction of the fruit bunch. On the leaves the fungus is usually confined to the leaf bases, therefore only those portions of the leaf stalk showing the white strands need be dealt with. All non-fecundated fruit bunches on such trees should be cut out and burnt.

During the rainy months burning will be practically impossible, but it is more necessary to take precautionary measures during wet periods because of the profuse development of the fructifications of the fungus, with consequent liberation of millions of spores. If burning cannot be undertaken, a bath of 5% Izal should be made up, and all affected material dipped thoroughly for several minutes. This material should then be piled in various places, and inspection of these piles of decaying vegetable material should be made at intervals. If fruit bodies of the fungus are found developing during these inspections the piles should be drenched with a 5% solution of Copper Sulphate. This inspection work should be continued until the weather is sufficiently dry to enable the piles to be fired, which should be done at the earliest opportunity.

On palms with the fungus prominent on the leaf-bases only, the non-fecundated bunches should be cut out and burnt and any affected leaves which can be cut without losing mature fruit bunches should be dealt with as indicated above. On some leaves, the white strands will be found growing out round the underside of the leaf-base; these leaf-bases can be painted with a 5% solution of Izal, or 20% solution of Agrisol, and an endeavour should be made to get the painting solution on the inside of the leaf-bases.

The cleaning up operations will gradually reduce the amount of decaying vegetable matter and so the opportunities of the fungus for growth and reproduction. Pruning of the leaves will allow freer air circulation and decrease atmospheric humidity, both of which factors will retard the growth of this fungus, but the pruning of leaves cannot be overdone; those which subtend mature fruit-bunches must be allowed to remain on the tree for purposes of support.

Control Measures on Dwarf Coconut Palms.

The control measures on Dwarf Coconuts require a general cleaning up of the decaying mass of vegetable tissue consisting of the lower leaves and strainers which remain attached to the tree.

Green leaves, showing the fungus prominently, must be cut off, even if the ripe nuts have to be sacrificed. In some cases, the fungus strands will be found growing on the outside of leaf-bases, with which the inside of a badly affected lower leaf has been in close contact. In these cases, the outside of the leaf-bases should be painted as directed for Oil Palms.

Control Measures on Tall Coconuts.

Control measures for affected Tall Coconut Palms will be similar in (a) cases of typical Lightning-strike; (b) in the areas where large numbers of palms, showing similar symptoms are affected, and (c) in areas where the palms are retrogressing owing to unsuitable growth conditions.

In cases (a) and (b) the dead and badly affected palms must be cut out immediately and the leaves and upper parts of the stem destroyed. About two feet of the comparatively soft stem tissue below the crown should be treated immediately as this part of the stem seems to be the favourite portion which the Black Beetle (*Oryctes Rhinoceros*. Linn.) selects as breeding places. Some palms, which do not appear badly affected

on first inspection will later show more definite symptoms and these must also be promptly treated to prevent the multiplication of this insect. In the event of wet weather it would be advisable to pay special attention to the lower part of the leaf not bearing leaflets, and any showing white fungus strands at the base should be dipped in a 5% solution of Izal. The leaf trash should be piled and inspected and treated as indicated in the case of affected Oil Palms, until burning can be undertaken. The stems and roots should be cut up, and split and piled to await a convenient opportunity for burning.

Slightly affected trees with leaves hanging, broken or tipped, should be cleaned up by cutting off all leaves showing such symptoms. This will make supervision over these trees much easier, for after cutting such leaves away, it will be easy to keep a strict tally and to judge whether the affection is making progress by noting whether healthy leaves, previously intact, become broken or tipped. The cut leaves, on such trees, should be treated as indicated above, firing to be undertaken as soon as weather conditions permit.

Up-to-date none of the palms showing stem bleeding have succumbed although badly affected by the boring beetle, and it will be necessary to wait longer before advice can be given on this point. On one estate a thick lime-wash was used to protect the stems, but the borers penetrated into the stem tissues in spite of this precaution.

In the (c) areas, the badly affected trees should be treated similarly. Most affected leaves are hanging and but few broken or tipped. These affected leaves should be cut away and treated as indicated above. On these areas, large accumulations of decaying vegetable matter are always present; this decaying material should be piled, and during wet weather treated as detailed for Oil-Palms; on the onset of favourable conditions the piles should be destroyed by fire.

In conjunction with these sanitation methods, measures designed to improve soil conditions should be undertaken. There is little definite knowledge regarding methods to be adopted, but applications of a lime and fish manure mixture have brought about definite improvements in 12-18 months' time. Other methods are in operation but it is too early to state whether they will be successful or otherwise. Further reports on these features will be issued later as definite results are obtained.

PART II.

Palm Diseases and Associated Fungi.

(a) Diseases of Coconut and Areca Palms associated with *Polyporus ostreiformis*. Berk.

Apart from *M. palmivorus*, observations have been made on several other fungi associated with diseased conditions on various palms.

In Malaya, the Areca Palm, (*Areca Catechu*. Linn.) and the Royal Palm (*Oreodoxa Regia* H. B et K.) suffer from some form of disease which progresses in a manner typical of a root disease spreading by root contact. In the case of the Areca Palm, there is some evidence that *Polyporus ostreiformis*. Berk. is definitely associated with the disease; this fungus has also been found associated with a stem disease of Tall Coconut Palms.

P. Ostreiformis. Berk. on Coconut Palms.

In June 1926 diseased specimens of Coconut Palms were obtained which showed the white, spongy fructifications of a Polyporus sp. The stem sections, on which the fruit-bodies were growing profusely, were taken about 20 ft. high, and the cross section showed a soft central core rot about 6 inches in diameter, with a hard outer ring of tissue about 1½ inches wide. The fructifications were growing from the cut ends of the section.

The soft central tissues did not show the typical deep salmon-pink discoloration with yellow patches; the discoloration in this case was a brownish-pink. Sections, stained with Cotton Blue, showed numerous hyphae in the tissues.

The logs with fructifications were placed outside the laboratory under shade. Within three days the fructifications were found to be a crawling mass of caterpillars and the soft spongy tissue, of which the fruit bodies are formed, was almost completely disorganised. The eggs from which the caterpillars developed, must have been laid in the fruit-bodies

immediately after they were formed. The caterpillars were bred out by the Government Entomologist and were found to be a stage in the life-history of a small Tineidae moth, *Scardia sistrata*. Meyr.

Fructifications were submitted to the director of the Singapore Botanic Gardens, who identified the fungus as probably *Polyporus ostreiformis* Berk. This diagnosis was confirmed later by Dr. J. R. Weir, Mycologist to the Rubber Research Institute, Kuala Lumpur F.M.S. The specimens kept in the Singapore Herbarium were reported to be badly damaged by insects; the comparative scarcity, in Malaya, of fructifications of this particular species on rotting Coconut logs, may be accounted for by the rapid disintegration brought about by the activities of the caterpillars in the spongy tissue of the fructifications.

Some of the stem sections showing immature fruit-bodies, were kept in the laboratory wash-basin, with water dropping continuously. The development of the fructifications took place rapidly and the specimens retained their identity for many months, not becoming overgrown with other organisms, as is commonly the case with rotting Coconut material placed under similar conditions. These stem sections were invaded by practically a pure culture of *P. ostreiformis* Berk. After several months various insects appear in these rotting sections and help towards complete disintegration of the tissues. The two commonest are the Tenebrionids, *Platydenia sudfascia*. Walk. and *Ceropria subocellata*. Cast.

The bracket fructification commences as a small button, yellowish white on top, pure white below. The tissue of the fructification is spongy from the commencement and remains so. As the fruit-body increases in size, the upper surface becomes greyish in colour, with definitely marked, radiating lines spreading from the point of attachment at the stem to the edges. There is a definite yellowish margin on the under surface; this margin is of the same colour as the top surface, and the remainder of the under surface is pure white. The bracket fructification grows to a size of about two inches across. (Plate 15).

The specimens grown in weak diffuse light show a pure white upper surface.

If the stem sections are stood on end, instead of lying flat, a resupinate form of fruit-body, sometimes corrugated, pure white in colour, develops. (Plate 16).

P. Ostreiformis. (Berk.) on Areca Palms.

The areca palms under investigation were all grown in lines to form a single avenue. The mode of degeneration is very typical. The crown of leaves becomes smaller, the individual leaves take on a yellowish colour, and finally the crown falls or is blown off, leaving a bare pole.

Before the failure of the crown is specially noticeable, the tissue at the base of the stem begins to decay and fall away on one side of the stem, leaving the inner stem tissue exposed; this decay goes on progressively until, in advanced cases, only the outer shell of the stem is left at the base, while the decay may progress for 8-10 ft. up the stem along one side. On the edges of the diseased woody stem tissues, the honeycomb structure, often seen in woody tissues attacked by Polyporus and Fomes sp., is commonly found.

During the past year isolations from diseased Areca palms grown in three different districts have given the same cultures as those described above. Fructifications of *P. ostreiformis* (Berk) have been obtained on two occasions from diseased Areca palms. As regards Areca palms, the common association and mode of attack suggest that this fungus can attack these palms; in the absence of successful inoculation experiments the suggestion must be accepted with reserve.

Pure Cultures of P. Ostreiformis (Berk).

Cultures of this fungus were first established on Coconut wood Blocks in Roux tubes. The inoculum used was diseased tissue from Tall Coconut Palms. The cultures started well, but did not make much progress after a certain time had elapsed; transfers were then made to blocks of sterilised Rubber Wood, contained in Roux tubes with abundant water. Growth was very profuse on Rubber Wood blocks, the pure white mycelium growing up the sides of the tube, to the plug of Cotton Wool, in some cases. In the majority of cases, growth ceases before reaching the plug, the hyphae mass together to form a fairly solid cushion, brownish in colour. The cultures at this stage are 4-6 weeks old. Cultures started on 17.6.26 were producing *atypical* fructification on 10.1.28.

(b) Notes on other Fungi Isolated from Diseased Coconut Roots.

Several interesting fungi have been isolated from diseased Coconut Roots. Two of these were sent to the Imperial Bureau of Mycology for study. Diseased roots of Coconut palms often show definite black lines running through the diseased tissue, and the fungi under discussion, were obtained in attempting isolations from these black lines.

The two species isolated in 1924 from a two year old Coconut palm and sent to the Imperial Bureau of Mycology, were a new Absidia sp.—*Absidia Butleri*, Lend, and a Hyphomycete producing a black spored fungus of the *Acremoniella* type. The full reports on these fungi will be given in a later issue of the M.A.J.

Inoculation experiments on Coconuts roots were carried out with pure cultures of the above mentioned fungi; the results with *A. Butleri* n.s. Lend, were negative. The *Acremoniella* sp. possessed definite slowly-penetrating powers, but not to the extent to be expected from a vigorous parasitic fungus. In 1926, mature Coconut palms, with diseased roots showing black lines were found. Isolations from the black lines gave two fungi different from those isolated in 1924. In this case the two fungi isolated were a *Torula* sp. and a *Phoma* sp. The latter turned up quite pure in the majority of cases. The vessels in the rubber wood blocks on which the fungus was growing were crowded with the round, black fruiting bodies; at first it was thought that these black rounded fruit-bodies might be the sclerotia of *Rhizoctonia bataticola* (Taub). Butl.,—*Macrophomina phaseoli*, Ashby, but closer investigation showed them to be the pycnidia of a Phoma sp.

It may be interesting at this juncture to report that specimens of Coffee sp. suffering from root disease have been examined this year. A careful examination of the finer roots showed spherical black bodies in the cortex and vessels and these proved to be the pycnidia of a Phoma sp., practically indistinguishable from those isolated from diseased Coconut roots.

The subject of fungi associated with diseased Coconut roots cannot be passed without reference to Small's claims regarding *Rhizoctonia bataticola* (Taub) Butl. being suspected to be the cause of Coconut root disease (16). Since these

claims were put forward a careful and thorough search for the black sclerotia of this fungus has been made through diseased roots of Areca palms, Dwarf Coconuts, Tall Coconuts and African Oil Palm, but without success. No traces of *R. bataticola* have been found in material recently taken out of the ground but examination of old preserved material, showed black sclerotia of *R. bataticola* in the roots of the two year old palms from which the *Absidia* and *Acremoniella* isolations were made.

As regards the parasitism of *R. bataticola* on various tropical cultivated plants, remarks will be confined to the possibility of this fungus producing the black lines commonly found in diseased Coconut roots. As far as the writer is aware there is only one undoubted record of the presence of *R. bataticola* on Coconuts in Malaya, but if Small's view is understood correctly, he considers that the black lines in diseased Coconut roots are produced by this fungus, though his position is not clear on this point. However, he says with regard to this fungus on *Albizzia moluccana* seedlings (14) "On the majority of the seedlings the black lines of the fungus (*R. bataticola*) were well developed in the wood of the roots and base of the stem". If a similar remark represents Small's view with regard to *R. bataticola* and black lines in diseased Coconut roots, the evidence obtained in Malaya is definitely against this view.

Discussion.

Up to 1918, the Coconut disease position was largely influenced by the results published by Johnson (4) in his work relating to Bud-Rot. The uncritical acceptance of Johnson's inoculation results has led to much confusion in the past but it has been clear for the past few years that his technique was faulty. Briton-Jones in a recent article (3) comments as follows on the above-mentioned inoculation experiments:—"When the technique used in inoculation is taken into consideration the apparent success of the experiments is not surprising. After boring holes 45 cms deep with an augur into the tender tissues at the crown of a Coconut palm, it is evident that not much else is needed to cause its death."

Recent contributions relating to Coconut diseases lead the writer to think that confusion may again arise unless the present situation is clearly defined. In several contributions,

extracts of which are given below, the question of palm diseases seems to have been given undue prominence; in many cases it is obvious that the improvement of bad cultural conditions is of greater importance than the question of the cause and prevention of specific diseases.

Dowson (4) describing a disease in the vicinity of Mombasa says, "Palms planted round about the houses and between huts which are in the higher and therefore best drained ground were much larger, more vigorous than others planted at the same time on lower ground. The former were always kept clear, in fact the ground was practically bare of other vegetation; *the latter were growing in rank grass.* Furthermore the former commenced to bear in the fifth year, whereas the latter never showed signs of bearing before the seventh year after planting. Bud-Rot could not be found and has never been observed in the more vigorous palms about the houses and in the native encampment; whereas but a short distance away the disease was rife and the palms of Ceylon origin were without doubt the most susceptible".

Park (10) investigating a root disease of Coconut in Ceylon says:—"The symptoms of the disease of the young palms were a yellowing and subsequent death of the outer leaves which progressed inwards, dwarfing of the young central leaves, and in extreme cases, a rotting of the central bud followed by death of the palm. *The soil condition were poor, being of a very sandy and dry nature, with pools of brackish water in the vicinity.*"

Altson writing on Coconut diseases in British Guiana (1) says:—"The gradual elimination of the coconut palm in certain localities, which has now been in progress for some years as the result of the pathological condition known as "Bud-Rot" has been maintained with what appears to be accustomed severity. Consideration of the evidence which has been forthcoming has led me to believe that this disease is not induced by the operations of any specific organism, *but is primarily to be attributed to unfavourable soil conditions whose deleterious effects have in many instances been aggravated by cultural neglect.*"

"The selection of areas for planting this crop seem often to have been made without due regard to its requirements. *The cultivations which are at the moment the more severely affected are those situated either on low-lying, badly drained,*

heavy clay front lands, or on pegass soils which suffer from similar disabilities. The minimum of cultural treatment is given. At the best this consists in a very occasional weeding, and an equally infrequent cleaning of drains. I have been informed on some plantations that fields are picked only on their outskirts, for the bush, which has been allowed to grow up between the palms, prevents free access to their interior. And on more than one occasion I have found it impossible to progress through such "cultivations" without the aid of a cutlass, which was constantly needed to clear a path through a similar undergrowth. How long this form of neglect has been in operation I am not in a position to say, but I understand from a very early period in the lives of the trees".

Briton-Jones (3) after investigating diseases of Coconuts in Trinidad says:—"In all plantations where Bronze Leaf Wilt has been recorded, and in the majority of plantations where the disease does not occur, *the palms are planted generally at what appears to be just about half the proper distances apart.* The soils on which the disease (Bronze Leaf Wilt) is serious *are generally heavy, in very bad tilth,* and are constitutionally such that they do not drain well, and they dry out rapidly and crack in the dry season".

In these extracts, Altson appears to be the only investigator to give due prominence to the effects of planting Coconuts under unfavourable conditions, combined with subsequent neglect of appropriate cultural operations. In the present article, the writer wishes to emphasise that the observations have been made on the best estates in Malaya, on which no effort is spared to improve cultural conditions by draining and utilising methods which ameliorate poor soil conditions. All affected Coconut areas which have come under observation, in which the prominent features could be ascribed to soil conditions which could have been improved only with difficulty, at considerable expense and with doubtful results, have been rigorously excluded.

The present position in Malaya may be summarised as follows:—

(*a*) Up-to-date there is no evidence of an epidemic "Bud-Rot" disease caused by a Phytophthora species on any type of Palm.

(*b*) *M. palmivorus* is the direct cause of a disease on African Oil Palms and Dwarf Coconuts.

(*c*) *M. palmivorus* is a primary factor associated with various affections on Tall Coconut Palms.

(*d*) *Polyporus ostreiformis* Berk. is a fungus commonly associated with a root and stem affection on Areca Palms and has been found associated with affections of Coconut Palms.

(*e*) Attention is also drawn to several peculiar affections with which various organisms, both Bacterial and Fungi are associated.

I wish to record my best thanks to numerous planters interested in Palm cultivations who have shown their interest by help and kind hospitality, and to state that without such help, it would be impossible to make much progress in palm disease investigations. Special mention must be made of Messrs. L. P. Jorgensen, Batang Berjuntai, Capt. A. Pritchard, Capt. D. O. Jones, and Mr. G. A. R. Cowdroy of Bagan Datoh, Messrs. R. Paton, A. Keightley-Smith and V. Gregory, Banting, the late Mr. R. Roy, Province Wellesley, and Messrs. J. T. Nixon, H. Bryce, and H. D. A. Biddlecombe of Carey Island, for their continuous interest and help.

I also wish to thank Dr. E. J. Butler, Director Imperial Bureau of Mycology, Mr. R. E. Holttum, Director, Botanic Gardens, Singapore, and Dr. J. H. Weir, Mycologist, Rubber Research Institute, Kuala Lumpur, for help in identifying specimens.

1. Altson, R. A.—Report of the Assistant Botanist and Mycologist for year ending 31st December, 1924. Appendix III. Annual Report of the Department of Agriculture, British Guiana 1924.

2. Ashby, F. S.—Notes on two diseases of the Coconut Palms in Jamaica caused by Fungi of The genus Phytophthora. West Indian Bull., Vol. XVIII, 1920.

3. Briton-Jones, H. R.—Wilt diseases of Coconut Palms in Trinidad (Part I). Tropical Agriculture. May 1928.

4. Dowson, E. J.—Some observations of the Bud Rot Disease of Coconut Palms in the East Coast of Africa. Report of Proc. Imp. Bot. Conf., 1924, pp. 159-161.

5. Heusser, Dr. C.—Contribution to the study of the Crown Disease of the Oil Palm (Elaeis Guineensis Jacq.). General Series No. 31, Gen. Ex. station of the A.V.R.O.S.

6. Johnstone R. John.—The History and Cause of the Coconut Bud-Rot. No. 228, Bureau of Plant Industry, United States Department of Agriculture.

7. Rae W. Mc.—(i) History of the operations against Bud-Rot of Palms in S. India. (ii) Inoculation experiments with *Phytophthora palmivora* Butl. on *Borassus flabellifer*, Linn. and *Cocos nucifera* Linn.

8. Nowell, W.—Red Ring disease. West Indian Bull. XVII, 189, 1919 and XVIII, 73, 1920.

9. Nowell, W.—Diseases of Crop Plants in the Lesser Antilles. Published by the West Indian Committee, p. 29.

10. Park, M.—On the occurrence on Coconut of *Rhizoctonia bataticola* (Taub.) Butl. Myco. Notes. Tropical Agriculturist. LXVII 1926.

11. Reinking, O.A.—*Phytophthora faberi*. Maubl. The cause of Coconut Bud-Rot in the Phillipines. Phillip. Jour. Science Vol. XIV, No. 1, 1919.

12. Report Annual.—Annual Report of the Acting Director General Experimental Station of the A.V.R.O.S. 1st July, 1927—30th June, 1928. Medan 1928.

13. Sharples, A. and Lambourne, J.—Observations in Malaya on Bud-Rot of Coconut. Anns of Botany, January 1928.

14. Sharples, A.—Annual Report of Mycologist for 1924. Malayan Agric. Journ, Vol. XIII, July, 1925. No. 7 p. 218.

15. Small, W.—Further notes on *Rhizoctonia bataticola* (Taub) Butler. The Tropical Agriculturist, Vol. LXVIII, No. 2, Feb., 1927.

16. Small, W.—On *Rhizoctonia bataticola* (Taub). Butler, as a cause of root disease in the tropics. Trans. British Mycological Society. Vol. XIII. Parts 1 and 11 pp. 40-68.

EXPLANATION OF PLATES.

Plate 1. Transverse section of central salmon-pink internal discoloration of stem of Tall Coconut Palm.

Plate 2. As in Plate 1. Four transverse sections taken at different levels.

Palte 3. Longitudinal section showing central discoloration and characteristic break of Coconut stem with hardened, lignified stem tissue.

Plate 4. Photograph of leaf-base of Tall Coconut palm, showing typical position of white mycelial strands of *M. palmivorus*.

Plate 5. Photograph of Leaf-Base of Dwarf Coconut palm showing (right) fan-shaped patches of white mycelial strands of *M. palmivorus*. The specimen on the left also shows small fructifications of the fungus.

Plate 6. Typical Non-fecundated bunch of Oil Palm fruit, riddled with mycelium of *M. palmivorus*.

Plate 7. Leaf-base of Dwarf Coconut palms, showing small fructifications of *M. palmivorus*.

Plate 8. Photograph to show typical appearance of affected trees on Tall Coconut Estate. This plate and Plates 9-10-11 are photographs taken of a large group in which 150—200 trees were affected. Note tipped, broken and hanging leaves.

Plate 9. See Plate 8, a more general view.

Plate 10. See Plate 8, the characteristic appearance of the leaves is well shown in this photograph.

Plate 11. See Plate 8. Note specially the fallen leaves grouped round the bases of the trees from which they have fallen.

Plate 12. Fructifications of *M. palmivorus* developed in laboratory on Leaf-base of Tall Coconut palms. Slightly less than natural size.

Plate 13. Fructifications of *M. palmivorus* on mature Oil Palm bunch developed in Laboratory (almost natural size).

Plate 14. Fructifications of *M. Palmivorus* on leaf-base tissue of Dwarf Coconuts grown in Laboratory. Slightly less than the natural size. The small central fructification almost $\frac{1}{2}''$ across is about the size usually met with in the field.

Plate 15. Transverse section of Tall Coconut Stem showing at one end Bracket fructifications (right) of *P. ostreformis* Berk; at the other the white resupinate form of fructification. To obtain the photograph the original section was sawn into two pieces. The fructifications were developed in the laboratory.

Plate 16. Transverse section of Tall Coconut stem showing corrugated resupinate form, of *P. ostreformis* Berk. The half-section shows the trash which accumulates on the surface owing to the activities of beetles working in the interior.

Plate 17. Typical fructifications of *M. palmivorus* when grown under normal conditions. Natural size.

Plate 18. Fructifications of *M. palmivorus*, when grown under continuously dropping tap. Natural size.

PLATE 1.

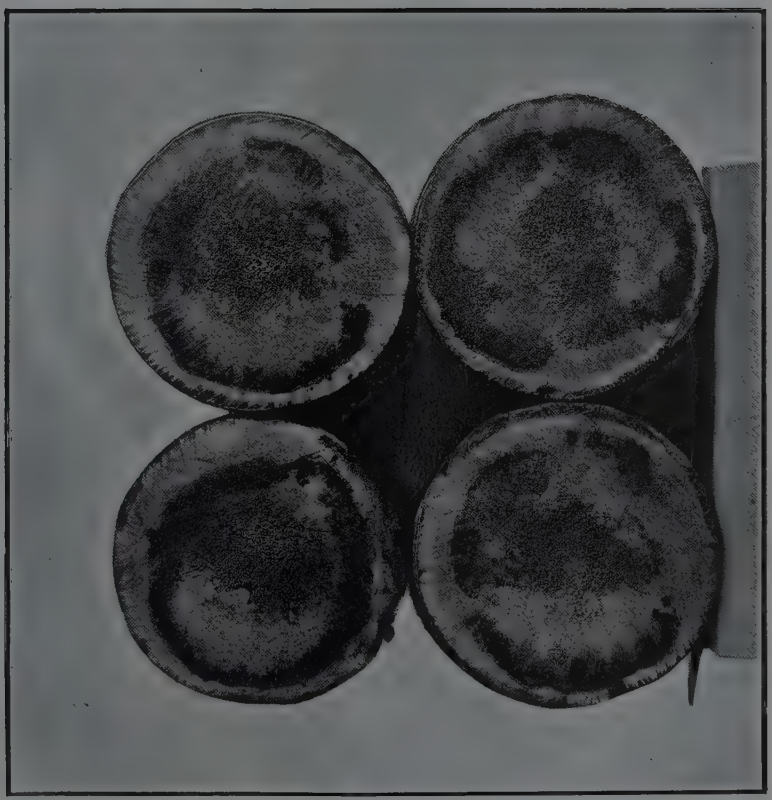


PLATE 2.

Plate 3.

Plate 4.

PLATE 5.

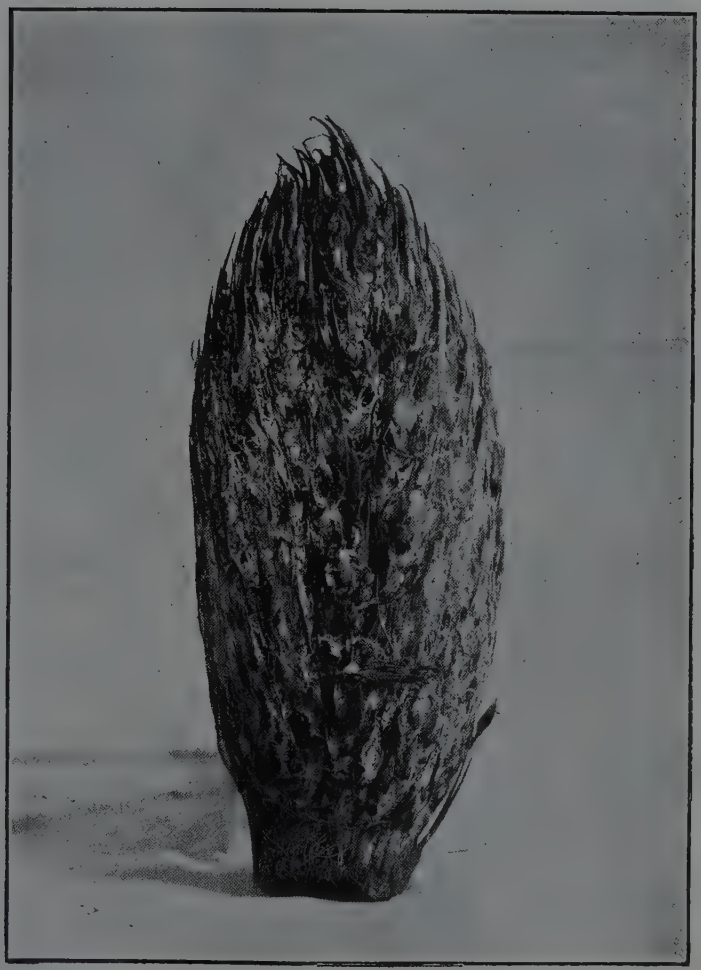


PLATE 6.

Plate 7.

PLATE 8.

PLATE 9.

PLATE 10.

Plate 11.

PLATE 12.

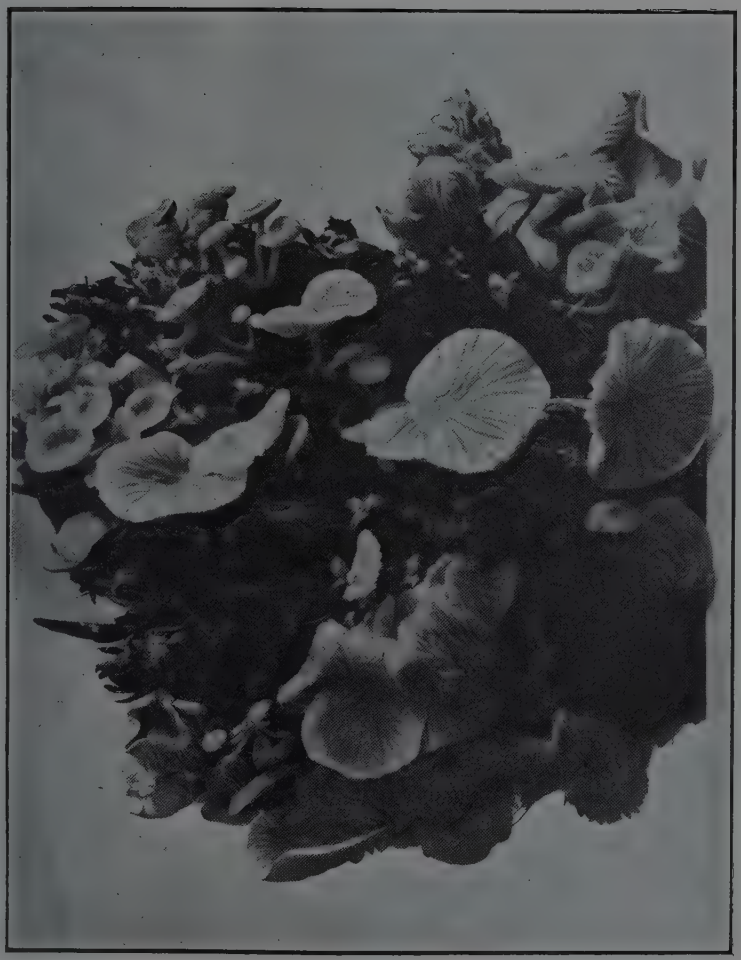


PLATE 13.

Plate 14.

PLATE 15.

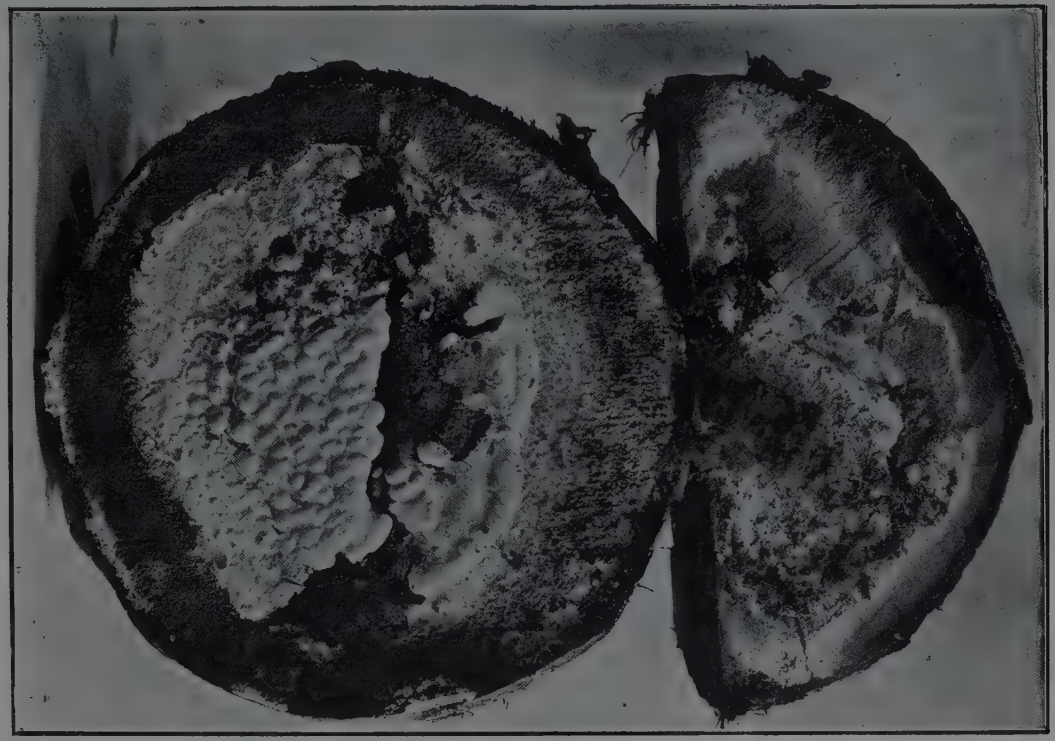


PLATE 16.

PLATE 17.

PLATE 18.